Total Pages: 2

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: CH201

Course Name: CHEMICAL PROCESS CALCULATIONS (CH)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Define ^{0}API, ^{0} Baume, ^{0}Twaddell &^{0}Brix gravity scales. (5)

b) A special manometer fluid has a specific gravity of 2.95 and is used to measure a pressure of 1.15bar at a location where barometric pressure is 760mm Hg. What height will the manometer fluid indicates? (4)

c) A chemist wanted to prepare 500ml of 1 Normal, 1 Molar & 1 Molal solution of H_2SO_4. Assume the density of H_2SO_4 solution to be 1.075 g/cc. Calculate the quantities of H_2SO_4 to be taken to prepare these solutions. (6)

2 a) State ideal gas law, Dalton's law and Amagat's law. (3)

b) Liquid Ammonia (specific gravity = 0.817) is vapourized and decomposed to form Nitrogen and Hydrogen. How many litres of product gas at 298K and 182.4kPa absolute would be formed from 50 litres of liquid ammonia? (6)

c) 1.10 kg of CO_2 occupies a volume of .033 m^3 at 300K. Calculate pressure using (6)
i) Ideal gas equation ii) Van der Waal's equation
Given that a = 3.6 $(m^3)^2$·kPa/(kmol) ^{2} b = .043 m^3/kmol

3

a) A mixed brine is electolysed and a gaseous mixture is obtained at cathode having the following composition by weight. (8)
Cl_2 =67% Br_2 = 28 % and O_2 = 5%
Calculate i) Composition by volume ii) Average molecular weight

b) A producer gas has the following composition by volume. (7)
CO =21%, CO_2 = 5%, O_2 = 3% and balance being N_2. Calculate the volume of this gas in m^3at 298K and 99.325kPa per kg of carbon present in it.

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive Clausius- Clapeyronequation fromClapeyronequation stating all the assumptions involved. (5)

b) Calculate the vapour phase composition at 60^{0}C in equilibrium with a liquid mixture containing 40 mole% benzene and 60 mole% toluene. (4)
Data given : vapour pressure of benzene at 60^{0}C = 385torr
vapour pressure of toluene at 60^{0}C = 140 torr

c) An air – water vapour sample at 101.3 kPa has a dry bulb temperature of 330.7K and is 20% saturated with water vapour. Using psycrometric chart, determine the following (6)
i) Absolute humidity
ii) Partial pressure of water vapour
iii) The absolute saturation humidity at 330.7K
iv) The vapour pressure of water at 330.7K
v) The % relative saturation
vi) Dew point of the system

5 a) The waste acid from a nitrating process containing 20% HNO_3, 55% H_2SO_4 and (8)

25% H_2O by weight is to be concentrated by addition of concentrated sulphuric acid containing 95% H_2SO_4 and concentrated Nitric acid containing 90% HNO_3 to get desired mixed acid containing 26% HNO_3 and 60% H_2SO_4.Calculate the quantities of waste and concentrated acids required for 1000kg of desired mixed acid.

b) 10000kg/h of solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from column carries 1% methanol. All percentages are by weight. Calculate (7)

i) mass flow rates of distillate and bottom products

ii) the percent loss of methanol.

6 a) What will be the yield of Glauber salt if pure 32% solution is cooled to 200°C from hot condition? There is no loss of water. The solubility of Na_2SO_4 in water at 200°C is 19.4g per 100g of water. (7)

b) An Ammonia converter is fed with 1:3 mixture of N_2 and H_2. The conversion to NH_3 is 27% based on N_2. The unconverted N_2 and H_2 are separated from NH_3 formed and recycled. Calculate (8)

i) the volume of fresh feed

ii) Volume of recycle to produce 6000kg of NH_3. All gases are at 2,5atm and 60^0C.

PART C

Answer any two full questions, each carries 20 marks.

7 a)) In a catalytic incinerator a liquid having a composition of 88% carbon and 12% hydrogen isvapourized and burnt with dry air to a flue gas of the following composition on dry basis. CO_2- 13.4%, O_2- 3.6% and N_2- 83% . Find (10)

i) How many kmol of dry flue gas are produced per 100kg of the liquid feed?

ii) What is the % excess air

b) In the oxidation of SO_2 to SO_3 the conversion is 75% by using 70% excess air. Calculate (10)

i) The composition of gases leaving the reactor on mole basis

ii) kmol of air fed per kmol of SO_2

8 a) A pure gaseous hydrocarbon is burnt with excess air. The orsat analysis of the flue gas is (10)

CO_2 – 10.2%, CO – 1% , O_2 – 8.4% and rest nitrogen. What is atomic ratio of H to C in the fuel. Find the %excess of air used.

b) Pyrites is roasted in producing SO_2. The gases leaving the roaster have a temperature of 500^0C with composition SO_2 – 9%, O_2- 8.6%, and N_2 – 82.4%. Composition of pyrites by weight is Fe- 35%, S- 40% and gangue 25%. If 100kg of pyrites roasted, Determine (10)

i) Excess air used ii) Volume of air suppliediii) Volume of burner gas leaving

9 a) State Hess's law of constant heat summation (3)

b) Calculate the theoretical flame temperature of a gas having 20% CO and 80% N_2 when burnt with 150% excess air. Both air and gas being at 25^0C. (10)

Data : Heat of formation of CO_2 = - 94052 cal/gmol at 25^0C.

Heat of formation of CO = - 26412 cal/gmolat 25^0C.

Cpm values (cal/gmol.K)- CO_2- 12.1, O_2 – 7.9, N_2- 7.55

c) Calculate heat formation of liquid ethyl acetate at 298K. (7)

Standard Heat of formation of CO_2 = - 393.51kJ/mol.

Standard Heat of formation of H_2O = - 285.83 kJ/mol

Standard heat of combustion of liquid ethyl acetate = -2230.91kJ/mol

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